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NATIONAL AERONAUTICS  
AND SPACE ADMINISTRATION  
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NASA-16285 (June 2004)  
NASA  
Superseding NASA-16285  
(October 2003)  
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DIVISION 16 - ELECTRICAL

SECTION 16285

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SECTION 16285

MEDIUM VOLTAGE POWER FACTOR CORRECTION  
06/04

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NOTE: Delete, revise, or add to the text in this  
section to cover project requirements. Notes are  
for designer information and will not appear in the  
final project specification.

This section covers metal-enclosed shunt capacitor  
equipment. Drawings should show voltage and kilovar  
ratings and mounting and connection details.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: The following references should not be  
manually edited except to add new references.  
References not used in the text will automatically  
be deleted from this section of the project  
specification.

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The publications listed below form a part of this section to the extent  
referenced:

ASTM INTERNATIONAL (ASTM)

ASTM A 1008/A 1008M (2004) Standard Specification for Steel,  
Sheet, Cold-Rolled, Carbon, Structural,  
High-Strength Low-Alloy and High-Strength  
Low-Alloy with Improved Formability

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 18 (2002) Shunt Power Capacitors

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD 595 (1994b) Colors Used in Government  
Procurement

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions

in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control. Include a columnar list of appropriate products and tests beneath each submittal description.

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The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES in sufficient detail to show full compliance with the specification:

#### SD-02 Shop Drawings

Connection Diagrams shall be submitted for the following in accordance with paragraph entitled, "General Requirements," of this section.

Metal Enclosed Shunt Capacitor Equipment  
Pole Line Capacitors  
Metal Enclosed Low-Voltage Capacitors

Fabrication Drawings shall be submitted for the following items in accordance with paragraph entitled, "General Requirements," of this section.

Capacitor Equipment

Installation Drawings shall be submitted for the capacitor equipment in accordance with the paragraph entitled, "Installation," of this section.

#### SD-03 Product Data

Equipment and performance data shall be submitted for the following items including life, test, system functional flows, safety features, and mechanical automated details.

Metal Enclosed Shunt Capacitor Equipment  
Pole Line Capacitors  
Metal Enclosed Low-Voltage Capacitors

Manufacturer's catalog data shall be submitted for the following items:

Metal Enclosed Shunt Capacitor Equipment  
Pole Line Capacitors  
Metal Enclosed Low-Voltage Capacitors

#### SD-06 Test Reports

Test reports shall be submitted for the following tests on Capacitor Equipment in accordance with the paragraph entitled, "Field Testing," of this section.

High-Voltage Tests  
Insulation-Resistance Test  
Capacitance Value Test

#### SD-07 Certificates

Certificates shall be submitted for Capacitor Equipment in accordance with paragraph entitled, "General Requirements," of this section.

#### SD-08 Manufacturer's Instructions

Manufacturer's instructions shall be submitted for Capacitor Equipment indicating the manufacturer's recommended operation instructions.

#### SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for the following equipment:

Metal-Enclosed Shunt Capacitor Equipment

### 1.3 GENERAL REQUIREMENTS

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**NOTE: If Section 16003 GENERAL ELECTRICAL PROVISIONS is not included in the project specification, applicable requirements therefore should be inserted and the following paragraph deleted.**

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Section 16003 GENERAL ELECTRICAL PROVISIONS applies to work specified in this section.

Connection Diagrams shall be submitted indicating the relations and connections of the following items by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Fabrication Drawings shall be submitted for the following items consisting of fabrication and assembly details to be performed in the factory.

Certificates shall be submitted for Capacitor Equipment showing compliance with the referenced standards contained in this section.

### 1.4 FACTORY TESTING

Tests on capacitor equipment shall include electrical and mechanical operational tests and dielectric tests. Dielectric tests shall be conducted in accordance with Testing Standards of IEEE Std 18 with 60-hertz withstand voltage rating equal to that of the switching device.

Certified copies of previous tests on similar equipment under actual conditions may be submitted for impulse tests, temperature-rise tests, and short-circuit tests in lieu of factory tests on actual units furnished.

## PART 2 PRODUCTS

### 2.1 METAL-ENCLOSED SHUNT CAPACITOR EQUIPMENT

Metal-enclosed shunt capacitor equipment for connection to 2,400-, 6,900-, and 13,200/13,800-volt, three-phase, 60-hertz circuits shall consist of a complete assembly of capacitor units including buses, connectors, current-limiting fuses, ventilating fans, switching devices, and controls housed in a weatherproof metal enclosure in accordance with IEEE Std 18. Control and protective devices shall be in accordance with Section 16286 OVERCURRENT PROTECTIVE DEVICES.

Capacitor units shall consist of polypropylene film and aluminum foil sections with series-parallel connections and discharge resistors contained in hermetically sealed welded steel cases with mounting flanges, immersed in a nonflammable liquid dielectric impregnant. Capacitor housings shall be bonded zinc-coated steel, resistant to corrosion, weather, and abrasion. Two insulating bushings with clamp tunnel connectors shall be sealed to the case of each unit and electrically connected to the capacitor section assembly. Characteristics of capacitor bushings shall be in accordance with IEEE Std 18. Discharge resistors shall reduce the residual voltage of the capacitor unit to 50 volts or less within 5 minutes after disconnection from the source of supply. Each capacitor shall have an individual insulating fuse. Capacitors shall operate satisfactorily at 135 percent of rated kilovars (kvar), 110 percent of rated voltage, and at ambient temperatures between minus 40 degrees and plus 46 degrees C. Voltage and kvar ratings for enclosed outdoor capacitor units rated at 60-hertz shall be in accordance with IEEE Std 18.

Pad-mounted capacitor equipment shall be housed in weatherproof, self-supporting, ventilated unit sheet metal compartments joined together to form a continuous structure, with hinged access doors, base and roof sections, roof seam covers, and end trims. Access doors shall be flanged and shall close against rubber or similar weatherproof gasketing material. Ventilating openings shall be provided with filtered louvers and screened vents. Doors shall be equipped with latches, stops, and door-locking mechanism. Base section shall be unit construction and shall support capacitor equipment 6 inches 150 millimeter above the concrete foundation. Base shall be designed for jacking and skidding. Lifting lugs shall be provided for unloading and moving equipment.

Sheet metal enclosures shall be constructed from cold-rolled carbon-steel sheets of commercial quality with stretcher-level flatness not less than 14 gage 1.9 millimeter, in accordance with ASTM A 1008/A 1008M. Each compartment shall be reinforced with structural members and welded together. Welds shall be ground to a smooth flat surface before painting. Capacitor equipment shall be provided with a ground terminal for grounding the stationary structure and equipment.

Capacitor compartments shall be provided with racks for mounting individual capacitor units in one, two, or three tiers, with not more than two rows of units per tier. Enclosures having one row of units per tier shall be accessible from one side only.

Phase and neutral buses for the connection and interconnection of capacitor units shall be bare rigid solid copper busbar of rectangular cross section, insulated from the enclosure. Contact surfaces of all main bus and cable tap connections shall be silver plated and bolted together to ensure maximum conductivity.

Phase and neutral buses for the connection to underground cables and capacitor units shall be bare rigid solid copper busbar of rectangular cross-section insulated from the enclosure. Contact surfaces of all main bus connections shall be silver plated and bolted together to ensure maximum conductivity.

Each capacitor unit shall be individually fused with current-limiting fuses that have an interrupting rating of 60,000 amperes and provide visual indication of fuse operation.

Top of capacitor compartments shall be provided with thermostatically controlled fans for forced-air ventilation of capacitor units. One 1/4 horsepower 190 watt motor-driven fan shall be provided for each 600 kvar of installed capacity or fraction thereof. Fan motors shall be for 115-volt, single-phase, 60-hertz current and shall be individually fused or thermally protected. Thermostats shall control the operation of fans within prescribed temperature limits.

Power entrance compartments shall include insulated phase and neutral bus, a short-circuiting and grounding switch, and provisions for terminating underground cables.

Short-circuiting and grounding switch shall be mechanically interlocked with all capacitor compartment doors to prevent access to capacitor units unless phase and neutral buses are short circuited and grounded. Short-circuiting and grounding switch shall be Kirk key-interlocked with the remote circuit disconnecting and protective device to ensure the proper sequence of operation.

## 2.2 POLE LINE CAPACITORS

Pole line capacitors shall be power line, power factor connection type for 2.4 kilovolts (kV), 5 kV, and 13.2/13.8 kV, 60 hertz and shall be located and installed as indicated. Pole supporting hardware shall be hot-dip galvanized steel designed for NEMA standard capacitor units. Attachment hardware shall be corrosion resistant. Poles supporting capacitors shall not be smaller than 8 inches 200 millimeter in diameter at the point of attachment.

## 2.3 METAL-ENCLOSED LOW-VOLTAGE CAPACITORS

Metal-enclosed capacitors for 600-volt circuits and below shall consist of individual enclosed units with insulators, connectors, and hardware housed in a protective enclosure. Individual cells shall be fused and provided with discharge resistors to reduce voltage to 50 volts or less in 1 minute.

Capacitor banks shall operate within a range of plus or minus 40 degrees C. Capacitor cells shall be impregnated with a nonflammable (PCB-free) dielectric. Capacitor banks shall be provided in banks with welded, 14-gage, 1.9 millimeter, ASTM A 1008/A 1008M steel, zinc coated. All other requirements shall be as required for high-voltage installation. Paint color shall be in accordance with FED-STD 595.

## 2.4 PREVENTION OF CORROSION

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**NOTE: For all outdoor applications and all indoor applications in a harsh environment refer to Section**

09960 HIGH PERFORMANCE COATINGS. High performance coatings are specified for all outdoor applications because ultraviolet radiation will break down most standard coatings, causing a phenomena known as chalking, which is the first stage of the corrosion process. For additional information contact The Coatings Industry Alliance, specific suppliers such as Keeler and Long and PPG, and NACE International (NACE).

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Metallic materials shall be protected against corrosion. Equipment shall have the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive action), and all outdoor installations, refer to Section 09960 HIGH PERFORMANCE COATINGS.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Capacitor equipment shall be installed and connected in accordance with the manufacturer's installation instructions.

Ground connections shall be made to a driven ground rod or counterpoise, as indicated.

Installation Drawings shall be submitted for the capacitor equipment. Drawings shall include details of equipment room layout and design.

#### 3.2 FIELD TESTING

Main bus of high-voltage capacitor equipment shall be disconnected from the circuit cables, and the capacitors and the equipment enclosure shall be grounded before conducting insulation and high-voltage tests.

Main bus of capacitor equipment shall be given an insulation-resistance test with a 5000-volt insulation test set for units 5 KV and above, 2,500-volt insulation-resistance test set for units 2.4 kV to 5 kV, and 1,000 volts for units 600 volts and below.

Tests shall be applied for not less than 5 minutes and until three equal consecutive readings, 1 minute apart, are obtained. Readings shall be recorded every 30 seconds during the first 2 minutes and every minute thereafter. Minimum acceptable resistance shall be 100 megohms.

Upon satisfactory completion of the insulation-resistance test, main bus shall be subjected to a high-voltage DC (Hi-pot) test. Test voltage shall be equal to 75 percent of the factory test values and shall be applied for 1 minute.

Upon satisfactory completion of all bus testing the capacitor's value shall be confirmed by performing a Capacitance Value test. Discharge the capacitor and measure the capacitance per the manufacturer's instructions. The measurement shall be between 100 percent and 110 percent of nameplate. Values between 90 percent and 100 percent, and 110 percent and 120 percent require investigation. Values outside these limits indicate a shorted groups of internal layers and the capacitor shall be considered defective.

Upon satisfactory completion of the capacitance test the capacitor shall be subjected to a dielectric strength test using a DC voltage of 75 percent of the original factory test voltage. Test voltage should be held for 10 seconds. During application of test voltage listen for any indication of internal arcing. If any is heard the unit is defective.

Upon satisfactory completion of the dielectric test the capacitance of the capacitor shall be remeasured to insure no damage had occurred during the dielectric test. Results shall not vary more the 2 percent over the original readings.

Final acceptance shall depend upon the satisfactory performance of the equipment under test. Capacitor equipment shall not be energized until recorded test data have been approved by the Contracting Officer. Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --